This document is an English translation of the Preliminary Report on the fatal accident involving the Boeing 747-412F aircraft registered TC-MCL that occurred on January 16, 2017 at Manas International Airport, Bishkek, Kyrgyz Republic.
The translation was done as accurate as a translation may be to facilitate the understanding of the Preliminary Report for non-Russian speaking people. The use of this translation for any purpose other than for the prevention of future accidents could lead to erroneous interpretations. In case of any inconsistence or misunderstanding, the original text in Russian shall be used as the work of reference.

INTERSTATE AVIATION COMMITTEE

AIR ACCIDENT INVESTIGATION COMMISSION

PRELIMINARY REPORT

Type of occurrence	Fatal accident
Type of aircraft	Boeing 747-412F
Registration mark	TC-MCL
Owner	LCI Freighters One Limited (Ireland)
Operator	ACT Airlines
Aviation Authority	Turkish DGCA
Place of occurrence	Near Manas International Airport, Bishkek, Kyrgyz Republic, coordinates: N 43°03.248' E 074°2.271'
Date and time	16.01.2017, 07:17 local time (01:17 UTC), nighttime

In accordance with ICAO Standards and Recommended Practices this Preliminary Report has been published with the sole objective of aircraft accident prevention.

It is not the aim of this investigation to apportion blame or liability.

The criminal aspects of this accident are described within a separate criminal investigation.

This Preliminary Report has been released before the investigation has been completed in compliance with Para 7.4 of ICAO Annex 13. The report contains factual information currently available to the investigation team as well as findings of examinations conducted by the time of its release. In case additional information becomes available, the Report may be clarified and updated.

The investigation team is analyzing operational and maintenance documentation related to the accident as well as onboard and ground recorders data.

An FCC recovered from the accident site has been sent to the NTSB in Washington DC, USA for specific examinations.

ILS recorded data are being analyzed.

Upon completion of the investigation activities, Final Report will be drafted.

SYNOPSIS **7**

1. FACTUAL INFORMATION **8**

1.1. History of Flight 8
1.2. Injuries to Persons 11
1.3. Damage to Aircraft 11
1.4. Other Damage 12
1.5. Personnel Information 12
1.6. Aircraft Information 17
1.7. Meteorological Information 18
1.8. Aids to Navigation, Landing and ATC 19
1.9. Aids to Communication 23
1.10. Airdrome Information 23
1.11. Flight Recorders 24
1.12. Wreckage Information 24
1.13. Medical and Pathological Information 27
1.14. Survival Aspects 27
1.15. Search and Rescue Operations 27
1.16. Tests and Research 27
1.17. Organizational and Management Information 27
1.18. Additional Information 27
1.18.1. FMA FAULT 2 27
1.18.2. "GLIDESLOPE" alert (EGPWS Mode 5) 28

2. SAFETY RECOMMENDATIONS **29**

ABBREVIATIONS

AFDS	–	Autopilot Flight Director System
AGL	–	Above Ground Level
A/P	–	Autopilot
APU	–	Auxiliary Power Unit
ATC	–	Air Traffic Control
CAS	–	Calibrated Airspeed
CAT	–	Category
CG	–	Center of Gravity
CRM	–	Crew Resource Management
CVR	–	Cockpit Voice Recorder
DFDR	–	Digital Flight Data Recorder
DGCA	–	Directorate General of Civil Aviation (Turkey)
E	–	Eastern longitude
EGPWS	–	Enhanced Ground Proximity Warning System
EICAS	–	Engine Indication and Crew Alerting System
ELP	–	English Language Proficiency
FAA	–	Federal Aviation Administration, USA
FAF	–	Final Approach Fix
FCC	–	Flight Control Computer
FCT 747 (TM)	–	Boeing 747 Flight Crew Training Manual
FIR	–	Flight Information Region
FL	–	Flight Level
FMA	–	Flight Mode Annunciator (on PFD)
FO	–	First Officer
ft	–	feet
ft/min	–	feet per minute
IAC	–	Interstate Aviation Committee
ICAO	–	International Civil Aviation Organization
ILS	–	Instrument Landing System
IST	–	Ataturk Airport, Istanbul (IATA Code)
JED	–	King Abdulaziz International Airport, Jeddah, Saudi Arabia (IATA Code)

KAIK	–	Accident Investigation Board, Turkey
kt	–	knot
LH	–	Left-hand
LOC	–	Localizer
LMM	–	Locator, Middle Marker
LOM	–	Locator, Outer Marker
LPC	–	Line Proficiency Check
LTBA	–	Ataturk Airport, Istanbul (ICAO Code)
m	–	meters
MAC	–	Mean Aerodynamic Chord
MAP	–	Navigation display mode
MHz	–	megahertz
mps	–	meters per second
MSN	–	Manufacturer Serial Number
N	–	Northern latitude
N/A	–	Not applicable
ND	–	Navigation Display
nm	–	Nautical mile
NOSIG	–	No significant changes
NTSB	–	National Transportation Safety Board, USA
PIC	–	Pilot-in-Command
PF	–	Pre-flight
PFD	–	Primary Flight Display
QNH	–	Mean sea level pressure
RH	–	Right-hand
RVR	–	Runway Visual Range
RWY	–	Runway
SOP	–	Standard Operating Procedures
SN	–	Serial Number
STAR	–	Standard Arrival Chart
TAF	–	Terminal Aerodrome Forecast
TOGA	–	Takeoff/Go-around
TOW	–	Takeoff Weight

UCFM	–	Manas Airport, Bishkek (ICAO Code)
UTC	–	Universal Time Coordinated
VHF	–	Very High Frequency
VHHH	–	Chek Lap Kok Airport, Hong Kong (ICAO Code)
VOR/DME	–	VHF Omnidirectional Range/Distance Measuring Equipment
WGS	–	World Geodetic System

Synopsis

On January 2017 the crew of a cargo Boeing 747-412F a/c registration TC-MCL operated by ACT Airlines including Captain, FO, loadmaster and a/c technician were performing Flight TK 6491 transporting cargo from Chek Lap Kok Airport (VHHH, Hong Kong) via Manas Airport (UCFM, Bishkek) to Ataturk Airport (LTBA, Istanbul). Manas Airport was planned as a transit airport for refueling and crew change. The approach was conducted to RWY 26. The a/c overflown the entire length of the runway and impacted the ground near RWY 08 LMM. The a/c was totally destroyed in the accident. The 4 persons on board were killed. 35 local residents of Dacha-SU settlement were killed by the crashed a/c and ground fire, 37 local residents got injuries of varying severity.

The investigation team was appointed by Order № 1/814-p by Chairman of Air Accident Investigation Commission, IAC as of 16.01.2017.

In compliance with ICAO Annex 13 notification on the accident was sent to the National Transportation Safety Board (NTSB) of the State of Aircraft Design and Manufacture (USA) as well as to Accident Investigation Board (KAIK) of the State of Registry and Operator (the Republic of Turkey). The USA and Turkey have assigned their Accredited Representatives to participate in the investigation.

The investigation is participated by representatives of the NTSB, Federal Aviation Administration, USA (FAA), a/c manufacturer (the Boeing Company), KAIK, DGCA and ACT Airlines.

Initial actions at the accident site (securing the accident site, clearing the debris, evacuating the killed and injured) were performed by the local police and emergency services.

When completing the Preliminary Report the investigation team took into account information provided by the Ministry of Internal Affairs and Ministry of Emergency Response of the Kyrgyz Republic.

Currently the a/c fragments have been removed from the accident site and handed over for custody to the administration of Manas Airport.

Preliminary judicial investigation is conducted by the Ministry of Internal Affairs of Kyrgyz Republic.

1. Factual Information

1.1. History of Flight

The intended flight route was from Chek Lap Kok Airport (VHHH, Hong Kong) via Manas International Airport (UCFM, Bishkek) to Ataturk Airport (LTBA, Istanbul).

The calculated a/c TOW was about 342500 kg, with CG of 23% MAC.

The a/c departed from Hong Kong at approximately 19:12[1] on 15.01.2017. At 19:37 the a/c reached FL 320. Further, starting at 20:43 FL 340 was maintained. The flight was conducted in autoflight mode.

Before descending the crew conducted a low visibility approach and landing briefing.

The ILS (111.7 MHz) and VOR/DME MNS (113.4 MHz) frequencies for RWY 26 approach were tuned.

At 00:41 on 16.01.2017 the a/c entered Bishkek Area Control FIR. At 00:51 the crew reported they were ready for descent. The controller cleared descent to FL 220.

The descent from cruise flight level was initiated at approximately 00:52 at distance of 130 nm from VOR/DME MNS[2].

FL 220 was reached at approximately 00:59.

At 01:03:10 the crew requested further descent. The controller cleared descent to FL 180 to RAXAT reporting point (Figure 3).

At 01:05:55 the a/c reached FL 180. When overflying RAXAT the a/c was at that flight level.

At 01:06:02 the crew was handed over to Approach Control.

After the a/c overflew RAXAT the controller cleared further descent to FL 060 as per TOKPA 1 STAR.

Descent from FL 180 was initiated at 01:06:40 (a moment when the A/P FLIGHT LEVEL CHANGE mode was engaged). At its initial stage the crew used FLIGHT LEVEL CHANGE A/P mode longitudinally, while laterally LATERAL NAVIGATION mode was used. During descent the crew also used V/S mode. Engines operational mode was close to flight idle. Within 01:09:18 to 01:14:32 (FL 123 to FL 044) the crew extended spoilers manually.

TOKPA reporting point overflight occurred at 01:11:18. The a/c was crossing FL 092 while in descent. According to the approach chart, FL 060 or above should be reached when overflying TOKPA.

[1] Hereinafter unless otherwise stated UTC time is referred to.
[2] Hereinafter unless otherwise stated reference is made to distances from VOR/DME MANAS that is installed 0.8 nm before RWY 26 end (in direction open to landing course).

At 01:11:55 the controller informed the crew on transition level (FL 060), QNH (1023 hPa) and cleared them for ILS approach to RWY 26.

At 01:12:00 the crew set QNH.

At 01:12:07 at a speed[3] of 250 kt and distance of 12.5 nm the flap handle was set to 1°.

At 01:12:42 the controller cleared the crew for further descent to altitude 3400 ft[4]. The a/c was meanwhile crossing FL 074.

The CVR record of cockpit communications shows that at that stage of flight the crew was monitoring the flight altitude and was aware they were higher than the STAR chart.

At 01:12:51 at a speed of 240 kt and distance of 9.8 nm the crew started extending flaps to 5°. A bit later the crew identified the ILS three-letter identifier (India Bravo Kilo) for RWY 26.

At 01:13:35 at a speed of 220 kt and distance of 7.2 nm the flap handle was set to 10°.

At 01:14:05 the DFDR recorded LOC capture (Figure 1) and start of localizer establishing maneuver. At that time the a/c was at a distance of about 6 nm in descent at an altitude of approximately 5700 ft.

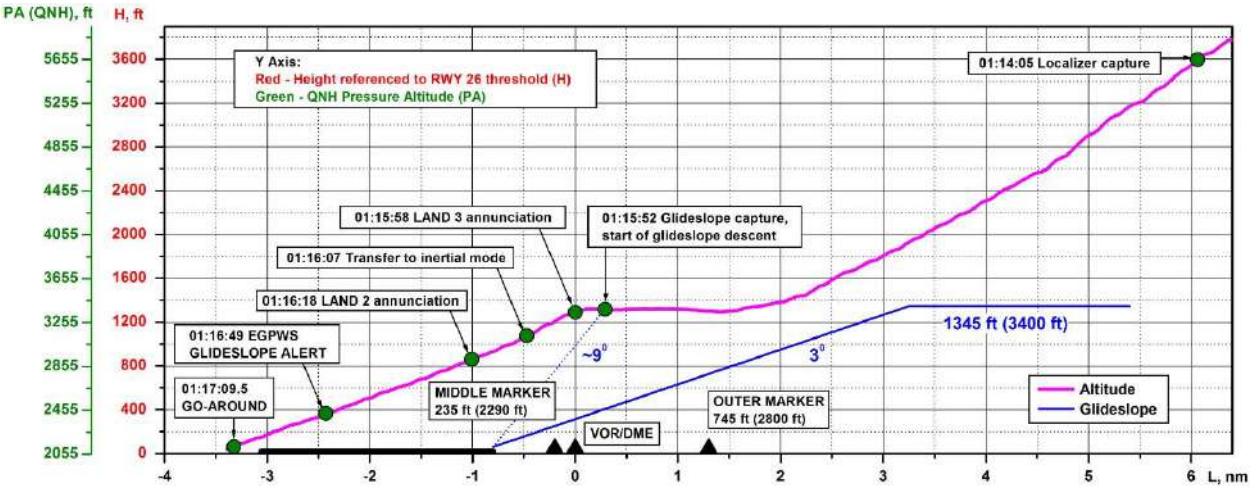

Figure 1. Vertical flight path of final approach (height is counted from RWY 26 threshold, its elevation being 2055 ft)

Since 01:14:08 the three A/Ps were engaged. Autoflight was continued, LOC MODE engaged laterally and FLIGHT LEVEL CHANGE was active vertically. 3400 ft was selected as target altitude (glideslope capture altitude). As per the approach chart (Figure 4) this altitude shall be reached at a distance of 5.4 nm and maintained until 3.2 nm (glideslope capture).

At 01:14:26 at a speed of 190 kt and distance of 4.5 nm the flap handle was set to 20°.

A bit earlier, at 01:14:18 the crew initiated landing gear extension.

[3] Hereinafter unless otherwise stated CAS values are referred to.
[4] Hereinafter unless otherwise stated QNH altitude is referred to.

The final approach point for RWY 26 is at a distance of 3.2 nm. At this distance, the a/c was in descent, crossing 4000 ft.

At 01:15:03 at a speed of 190 kt and distance of 2.7 nm the flaps were set to 25°.

At 01:15:21 after the crew confirmed capturing the localizer, the a/c was handed over to Tower Control.

At 01:15:25 at a distance of 1.7 nm the a/c reached 3400 ft and ALT HOLD OPER A/P mode was engaged longitudinally.

Since that time the flight was performed at a constant altitude along the RWY 26 landing course. The a/c was significantly higher than the glideslope, the glideslope pointer was in full down position. The glideslope mode was armed (G/S MODE ARM), but the glideslope was not captured.

At 01:15:31 while the a/c was in level flight at 3400 ft LOM overflight was recorded (as per the approach chart LOM overflight altitude is 2800 ft). The CVR record contained no aural signal of LOM overflight. However, the LOM is indicated to both crew members on the PFD.

At 01:15:38 the controller informed the crew on the weather (wind calm, RVR: 400 m (threshold), 325 m (midpoint), 400 m (end), vertical visibility 160 ft) and cleared them for landing. RWY 26 is certified for ICAO CAT II operations.

At 01:15:50 at a speed of 175 kt and distance of 0.3 nm the flap handle was set to 30°.

A glideslope signal was captured at 01:15:52, at that time the a/c was almost over VOR/DME MANAS at a distance of approximately 1.1 nm from RWY 26 threshold, at an angle of approximately 9° (Figure 1). However, as per the approach chart, the rated glideslope angle is 3°(Figure 4).

The a/c automatically initiated descent with a vertical speed of up to 1425 ft/min.

6 seconds after the glideslope capture LAND 3 autoland status annunciation was recorded. The crew called out the annunciation.

At 01:16:01 at 3300 ft LMM overflight was recorded (as per the approach chart LMM overflight altitude is 2290 ft). The CVR record contained no aural signal of LMM overflight. However, the LMM is indicated to both crew members on the PFD.

After the glideslope descent was initiated the glideslope pointer was fluctuating within – 4 to + 4 dots.

At 01:16:07, 15 seconds after the glideslope was captured, at 3150 ft AP CAUTION and FMA FAULT 2 events (See Section 1.18.1) were recorded. These events were continuously recorded almost until the end of the flight (until the FLARE A/P mode activation).

The descent was performed at approximately 160 kt CAS. The landing weight was about 274800 kg. MAP mode was selected on both pilots' navigation displays with scale range of 10 nm.

As the a/c was descending LAND 3 status degraded to LAND 2, which was confirmed by the crew callout.

Within 01:16:49 – 01:16:56 the EGPWS Mode 5 GLIDESLOPE alert was triggered 5 times (See Section 1.18.2). Further, the EGPWS system only provided information on reaching selected approach altitudes and minima.

At 01:17:04 the crew crossed RWY 26 departure end at a height of about 110 ft. At 01:17:05 EGPWS 100 ft radio altitude voice callout occurred while the decision height was 99 ft.

At 01:17:07 the FO called "Minimums".

At 01:17:08 the PIC informed that there was no visual contact («NEGATIVE») and called to go-around.

At 01:17:09 A/P Flare mode was engaged and half a second later at 58 ft radar altitude TOGA switch was pushed as per the DFDR.

The Go-Around mode activation resulted in engine power increase, vertical acceleration of about 1.4 g and arresting descent. 3.5 seconds after the TOGA switch had been pushed the a/c hit slightly upsloping terrain and obstacles. The ground speed at the time of impact was 165 kt. The maximum recorded vertical acceleration was 6 g.

Initial impact occurred at a distance of approximately 930 m from RWY 26 departure end. The collision with terrain and obstacles resulted in hull loss, most of the a/c structure was consumed by the post-crash fire.

1.2. Injuries to Persons

Injuries to Persons	Crew	Passengers	Others[5]
Fatal	4	0	35
Serious	0	0	37
Minor/None	0/0	0/0	0/0

1.3. Damage to Aircraft

The a/c was totally destroyed and partly consumed by the post-impact fire.

[5] Injured and killed persons on the ground

1.4. Other Damage

According to the information provided by the Ministry of Internal Affairs of Kyrgyz Republic, 38 buildings in the settlement were broken, including 19 dwelling houses and 12 household outbuildings totally ruined and 7 dwelling houses partly broken.

1.5. Personnel Information

Position	**Pilot-in-command**
Sex	Male
Date of birth	10.11.1958
Pilot's license	TR-A-04060
Date of issue	27.05.2015, TR-DGCA
Education	AIRFORCE ACADEMY, 30.08.1981
Weather minima	CAT III A
Total flight hours	10808 h
Flight hours on B 747	820 h
Flight hours on B 747 as PIC	820 h
Flight hours over last month	39 h 36 min
Flight hours over last 3 days	06 h 04 min
Flight hours on accident day	06 h 01 min
Total duty time on accident day	09 h 10 min
Breaks in operations over last year	None
Date of last check ride	23.04.2016 (LPC), Passed
Simulator training	28.09.2016
Pre-flight briefing	Conducted by PIC before departure in Hong Kong
Crew rest	From 12.01 to 15.01.2017 in Hong Kong (hotel)
Medical check before departure	N/A
Previous accidents or incidents	01.03.2010, A300-B4 TC-ACB, landing roll out on Bagram Airport's RWY 03. Involved as a First Officer. Collapse of a/c LH main landing gear.
Emergency evacuation training (Land)	21.01.2016

Emergency evacuation training (Water)	24.04.2015
Recurrent training	21.01.2016, JED
CRM Training	21.01.2016, JED
Medical examination	27.04.2016, Gazi Osman Pasa Hospital, Istanbul, 1 year
ELP level	ICAO Level 5, valid until 28.10.2019

Position	**First Officer**
Sex	Male
Date of birth	01.01.1958
Pilot's license	TR-A-07998
Date of issue	27.10.2014, TR-DGCA
Education	AIRFORCE ACADEMY, 30.08.1980
Total flight hours	5894 h
Flight hours on B 747	1758 h
Flight hours over last month	32 h 33 min
Flight hours over last 3 days	08 h 51 min
Flight hours on accident day	06 h 01 min
Total duty time on accident day	09 h 10 min
Breaks in operations over last year	None
Date of last check ride	06.12.2015 (LPC), Passed
Simulator training	11.05.2016
Pre-flight briefing	Conducted by the PIC before departure in Hong Kong
Crew rest	From 12.01 to 15.01.2017 in Hong Kong (hotel)
Medical check before departure	N/A
Previous accidents or incidents	None
Emergency evacuation training (Land) Emergency evacuation training (Water)	31.08.2016 31.05.2014
Recurrent training	31.08.2016, IST
CRM Training	31.08.2016, IST
Medical examination	18.08.2016, Dogan Hospital IST, 1 year

ELP level	ICAO Level 6, valid lifetime

Position	**Loadmaster**
Sex	Male
Date of birth	10.09.1975
Loadmaster's license	LM 129, issued by ACT Airlines, 10.08.2015
Education	Mustafa Kemal University, mechanic & maintenance associate degree, 1998
Total flight hours	4217 h
Flight hours on B 747	2431 h
Flight hours over last month	56 h 48 min
Flight hours over last 3 days	10 h 51 min
Flight hours on accident day	06 h 01 min
Total duty time on accident day	09 h 10 min
Pre-flight briefing	Conducted by the PIC before departure in Hong Kong
Crew rest	From 12.01 to 15.01.2017 in Hong Kong (hotel)
Medical check before departure	N/A
Previous accidents or incidents	None
Emergency evacuation training (Land) Emergency evacuation training (Water)	13.01.2016 27.09.2007
Recurrent training	13.01.2016
CRM Training	14.01.2016
Medical examination	14.10.2016, Dogan Hospital IST, 1 year

Position	**Aircraft Technician**
Sex	Male
Date of birth	20.05.1964
Technician's license	HBL 4514, issued by TR-DGCA, 09.06.2014
Education	AIRFORCE TECHNICAL SCHOOL, 1981

ATC Personnel Information

Position	Shift supervisor (at shift supervisor's working station at the time of the accident)
Sex	Male
Date of birth	12.07.1971
Education	Riga Higher Aviation School of Civil Aviation, graduated in 1991
Air Traffic Controller's License	AC-00106, issued by Civil Aviation Agency of Kyrgyz Republic, valid till 06.04.2018
Experience as air traffic controller	Since 1991
Qualification class	Class 1, Civil Aviation Agency of Kyrgyz Republic, Order № 42/л as of 07.02.2000
Authorizations	Upper Airspace Area Control, Approach
Recurrent training	Institute of Air Navigation, Moscow, September 2013
Simulator training	29.12.2016
On-the-job check	Upper Airspace Area Control, 17.10.2016, Approach Control, 18.10.2016
Annual medical examination	Medical examination board of Kyrgyzaeronavigatsiya, fit to work as air traffic controller, valid till 06.04.2018
ELP level	ICAO level 4, valid till 11.11.2019

Position	Senior Controller (at Approach Control working station at the time of the accident)
Sex	Male
Date of birth	12.03.1980
Education	Kyrgyz Aviation College, graduated in 1999
Air Traffic Controller's License	AC-00167, issued by Civil Aviation Agency of Kyrgyz Republic, valid till 18.05.2017
Experience as air traffic controller	Since 2000
Qualification class	Class 1, Civil Aviation Agency of Kyrgyz Republic, Order № 313 as of 07.06.2007
Authorizations	Ground Control, Tower Control, Approach Control, Upper Airspace Area Control

Recurrent training	Recurrent training Institute of Air Navigation, Moscow, October 2013
Simulator training	12.10.2016
On-the-job check	Approach Control, 17.10.2016 Ground Control and Tower Control 18.10.2016, Upper Airspace Area Control, 28.10.2016,
Annual medical examination	Medical examination board of Kyrgyzaeronavigatsiya, fit to work as air traffic controller, valid till 18.05.2017
ELP level	ICAO level 4, valid till 24.06.2018

Position	ATC Controller (at Tower Control working station at the time of the accident)
Sex	Male
Date of birth	06.07.1959
Education	Riga Higher Aviation School of Civil Aviation, graduated in 1979 Aviation Training Center, graduated in 1992
Air Traffic Controller's License	AC-00105, issued by Civil Aviation Agency of Kyrgyz Republic, valid till 22.12.2017
Experience as air traffic controller	Since 1992
Qualification class	Class 1, Civil Aviation Agency of Kyrgyz Republic, Order № 411 as of 12.10.2001
Authorizations	Ground Control and Tower Control
Recurrent training	Aviation Training Center of Kyrgyzaeronavigatsiya, 25.11.2016
Simulator training	29.11.2016
On-the-job check	Ground Control and Tower Control, 28.11.2016,
Annual medical examination	Medical examination board of Kyrgyzaeronavigatsiya, fit to work as air traffic controller, valid till 22.12.2017
ELP level	ICAO level 4, valid till 06.05.2018

1.6. Aircraft Information

Figure 2. Boeing 747-412F before the accident

Aircraft type	**Boeing 747-412F**
Manufacturer	The Boeing Company, USA
Date of manufacture	February 2003
MSN	32897
Registration mark	TC-MCL
Certificate of Registration	№ 3151, issued by Turkish DGCA, 10.12.2015
Owner	LCI Freighters One Limited (Ireland)
Certificate of Airworthiness	№ 3151 issued by Turkish DGCA, 08/12/2017.
Service life	Not established, in service depending on technical condition
Time since new	46820 h, 8308 cycles
Service life between overhauls	Not established, in service depending on technical condition
Last overhaul	None
Last base maintenance	06.11.2015, Delivery Check, Singapore Airlines Engineering Company at Singapore

	29.11.2016, A Check, ACT Airlines at Doha, Qatar
Last line maintenance	PF Check before departure from Hong Kong on 15.01.2017 by ACT Airlines maintenance personnel (Aircraft Flight & Technical Log, № 00837)

The a/c had PW4056-3 engines and PW901A APU mounted.

Engines	Engine #1	Engine #2	Engine #3	Engine #4
Type	PW4056-3	PW4056-3	PW4056-3	PW4056-3
MSN	P724497CN	P729032	P727958	P724322CN
Date of manufacture	25.02.1993	15.09.2001	16.12.1999	30.01.1991
Service life	On condition	On condition	On condition	On condition
Time since new, hours/cycles	87317/13962	56378/9769	47974/7170	90286/15306
Number of overhauls	2	2	1	3
Time since last overhaul, hours/cycles	4857/870	13407/2631	32149/4986	7323/1359
Date and place of last overhauls	29.05.2012, Eagle Services Asia	26.06.2012, Eagle Services Asia	14.08.2006, Eagle Services Asia	14.03.2012, Eagle Services Asia

The following history of service has been determined:

From February 2003 till 02.12.2015	Operated by Singapore Airlines, registration 9V-SFL
From 02.12.2015 till the accident	Operated by ACT Airlines, registration TC-MCL

1.7. Meteorological Information

At the time of the accident weather forecast for 00:00 on 16.01.2017 to 24:00 on 16.01.2017 was current for Manas Airport.

TAF forecast for Manas Airport:

Issued on 15.01.2017, at 22:44, valid from 00:00 on 16.01.2017 to 24:00 on 16.01.2017: surface wind 240° - 4 mps, visibility 0200 freezing fog, vertical visibility 030 m, TEMPO from 00:00 on 16.01.2017 till 06:00 on 16.01.2017 wind 120° - 5 mps, visibility 0800 m, freezing fog, smoke, vertical visibility 090 m, from 06:00 on 16.01.2017 surface wind 320° - 04 mps, visibility 1500 m, mist, clouds broken at 150 m, TEMPO from 06:00 on 16.01.2017 to 12:00 on 16.01.2017 visibility 0800 m, freezing fog, clouds few at 090 m.

Regular weather report for Manas Airport was broadcast via a VHF channel for 01:00 on 16.01.2017 in Russian and English:

Manas weather 01:00 surface wind calm, at 100 ft wind 110 degrees 01 mps, visibility 50 m RVR 300 m, freezing fog, vertical visibility 100 ft, temperature minus 09°C, dewpoint minus 10°C, QNH 1023 hPa, course 255, runway damp, braking action 0.6, NOSIG.

Actual weather at Manas Airport for runway course 255° at the time of the accident was as follows:

for 01:16: wind 60 degrees 01 mps, visibility: runway threshold 100/RVR 400 m, runway midpoint 100/RVR 350 m, runway end 100/RVR 400 m, vertical visibility 050 m, temperature minus 09°C, dewpoint minus 10°C, QNH 1023,9 hPa, RWY 26 damp, braking action 0.6, TREND NOSIG.

1.8. Aids to Navigation, Landing and ATC

To cover air traffic control objectives the following air traffic control units are present:

- Bishkek Area Control;
- Approach Control;
- Tower Control;

The ATC shift supervisor and Approach controller are seated in one room. Area and Tower controllers are in different rooms.

Navigational Support

Below is a list of ground navigation equipment supporting approach to landing for RWY 26:

- MSSR (Monopulse Secondary Surveillance Radar);
- ILS NM-7000 (111.7 MHz, IBK);
- VOR/DME (113.4 MHz, MNS);
- PAR-10C LMM (481 kHz);
- PAR-10C LOM (975 kHz).

The peculiarity of Manas International Airport is that ILS systems on both courses have the same frequency (111.7 MHz) while their letter identifiers are different. Based on the available information the system is configured in such a way that when the ILS for one course is engaged, the ILS for the other course is automatically disengaged.

STAR and approach charts are shown in Figure 3 and Figure 4.

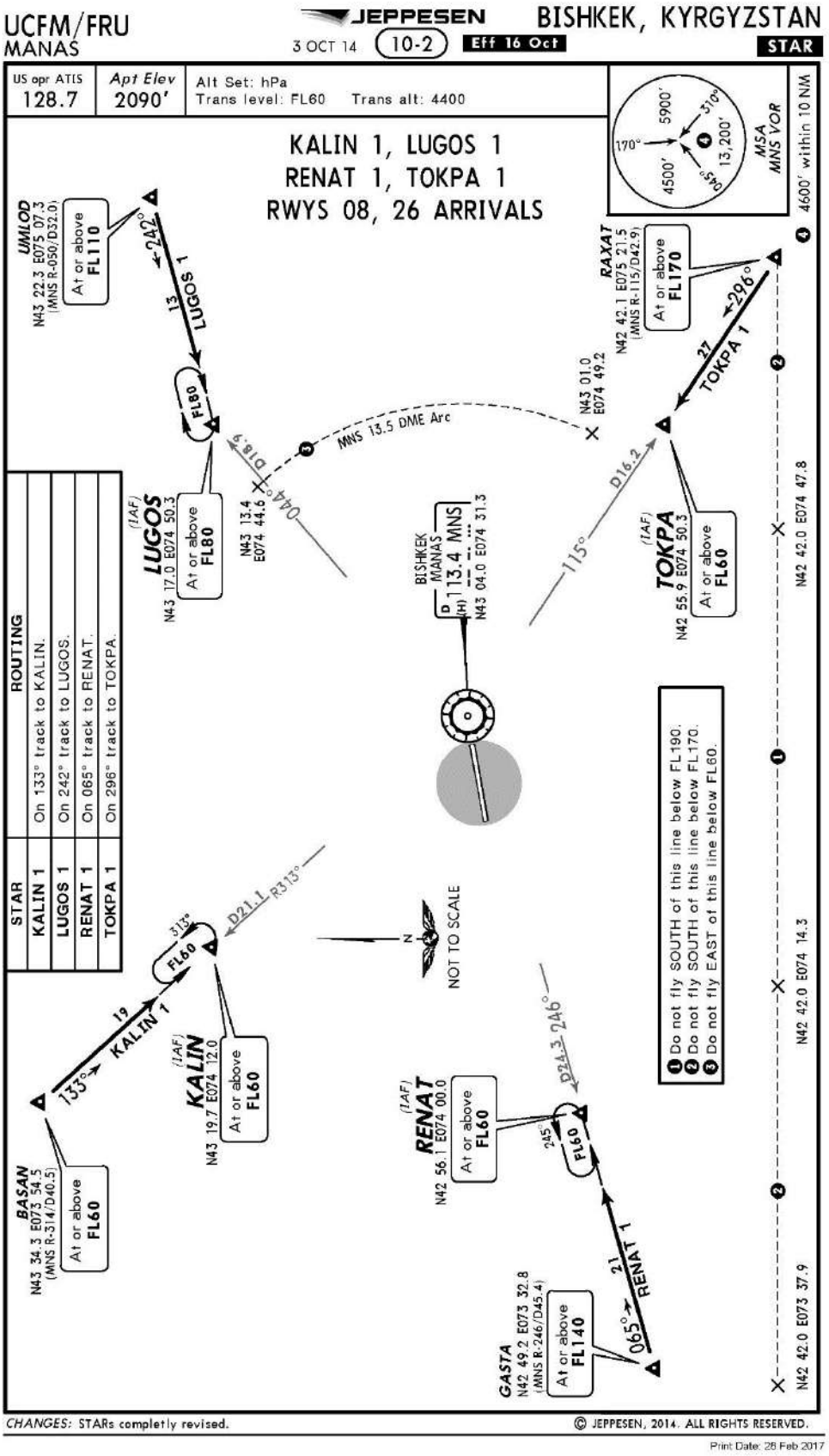

Figure 3. Standard Arrival Chart

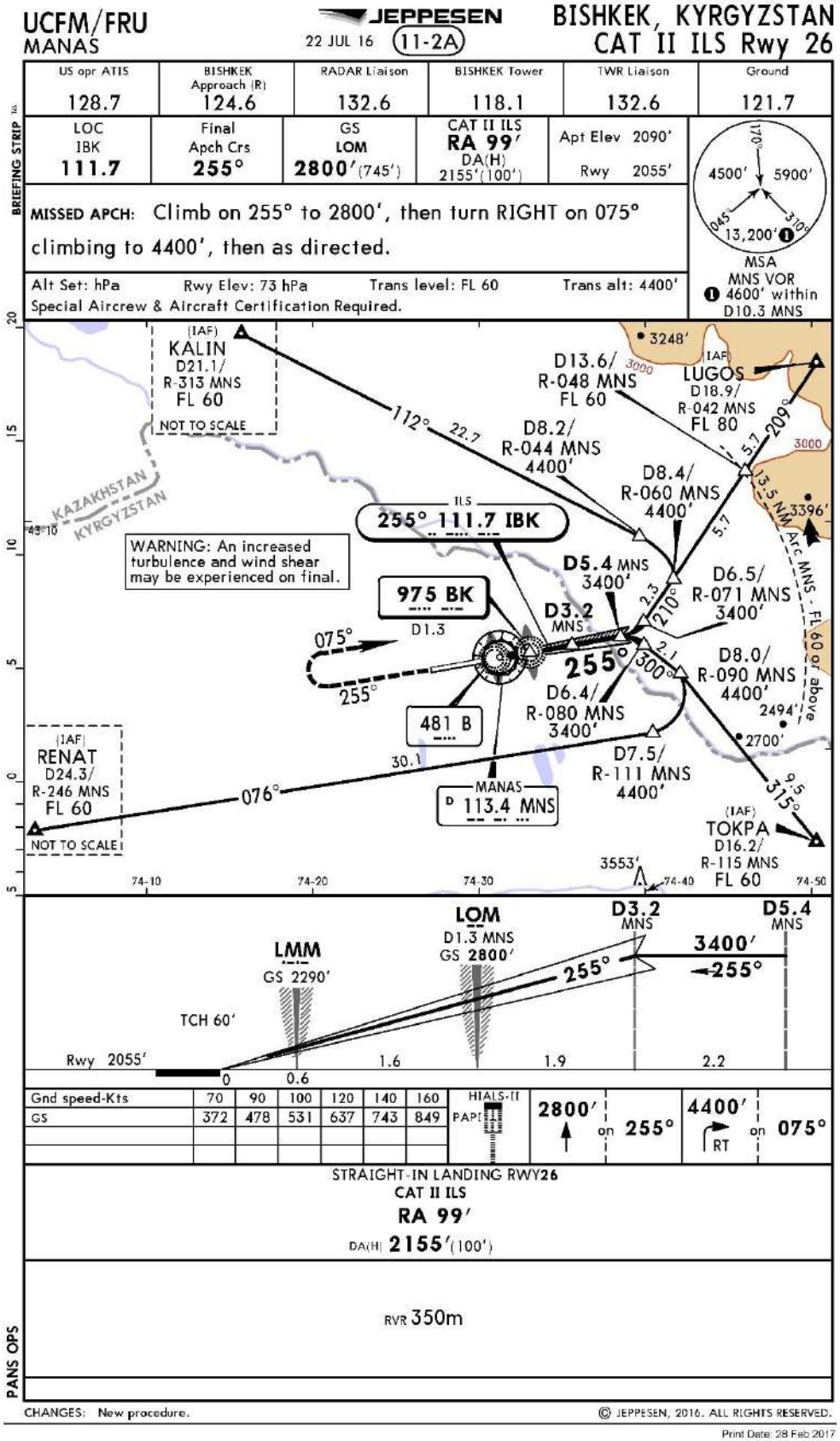

Figure 4. Approach chart for RWY 26

1.9. Aids to Communication

Manas Airport is equipped with the following communication aids:

- VHF radio stations;
- loudspeaking communications;
- telephone and telegraph communication;
- internal airport communication.

There is direct loudspeaking communication arranged between traffic control units in the airport. There is also loudspeaking operational communication (direct) between all of the ATC units, fully automatic telephone communication including access to city, intercity and international network, public network, as well as internal airdrome communication on airfield and ramps.

1.10. Airdrome Information

Manas Airport is 23 km to the north of Bishkek. Manas Airdrome with RWY 08/26 equipped for precise ICAO CAT II approaches holds Certificate of Airdrome Conformity issued by the Civil Aviation Agency, Ministry of Transport and Roads, Kyrgyz Republic, valid till 01.12.2017.

The airdrome has one runway, 4204 m long and 55 m wide. Airdrome designation - 4 E. The runway has 4.5 m wide perimeter pavement along its entire length (concrete for 2.5 m, asphalt-concrete for 2 m) on each side of the runway.

Runway surface is 40 cm thick fibercrete.

Runway longitudinal slope is 0.0026 (0.26%). There are no longitudinal slope changes of more than 1.5%.

Coordinates of Manas Airdrome as per WGS-84:

- ARP (Airdrome Reference Point): 43º03'40.58"N, 074º28'39.03"E;
- RWY 08: 43º03'28.74"N, 074º27'07.55"E;
- RWY 26: 43º03'52.40"N, 074º30'10.53"E.

ARP elevation - 2080 ft (634 m). Threshold elevation: RWY 08 - 2090 ft (637 m); RWY 26 - 2055 ft (626 m).

The airstrip is 4324 m long and 300 m wide. The clearway measurements are as follows: RWY 08 – 400x300 m; RWY 26 – 250x300 m, surface type - ground.

There are ground runway end safety areas for RWYs 08/26 measured 240x110 m.

Along its entire perimeter, Manas Airdrome is limited by concrete and metal net fencing. Beyond the airdrome, at a distance of about 1000 m from the threshold of RWY 08 there are dwelling houses and outbuildings of Dacha-SU settlement, their height not exceeding the pertinent limitations.

1.11. Flight Recorders

The a/c was equipped with the following flight recorders:

- DIGITAL FLIGHT DATA RECORDER HONEYWELL SSFDR 980-4700-042;
- COCKPIT VOICE RECORDER L3 FA2100 2100-1020-00.

The DFDR and CVR were found at the accident site near the separated tail empennage.

The recorders' readout was conducted at IAC laboratory with participation of experts from Kyrgyz Republic, Turkey and the USA.

The accident flight data were found intact. The record quality was good.

The readout results are being used to determine the causes of the accident.

1.12. Wreckage Information

The airframe was broken into multiple pieces, the largest of them being located within the last third of the wreckage path. The overview of the debris field is shown in Figure 5.

Figure 5. Debris field

The largest a/c parts found at the accident site were located in the following sequence:

- RH wing parts with flight control elements;
- engine #3 and #4 and their reverser elements;
- main landing gear with wheels;
- pieces of forward fuselage section (skin panels, frame, cargo door);
- nose landing gear with wheels;
- empennage with fin, stabilizer, pressure dome and APU;
- engine #2 with pylon pieces;
- engine #1, pieces of LH flight control surfaces;
- LH wing;

The post-crash fire cell was located in the central fuselage area, between the separated tail and cockpit (Figure 6).

Figure 6. **Main fire cell (circled by dashed yellow line)**

There are no signs of fire or thermal impact on the pieces of fuselage, wing and engines located before the fire cell, either on the outside or on the inside.

Beyond the debris field no airframe parts were found (fuselage, wing, empennage, etc.) that could have evidenced the a/c had been destroyed in-flight before the impact.

The vertical fin and horizontal stabilizers (Figure 7) remained attached to the tail part of the fuselage (pressure dome to the APU exhaust). Their final position was inverted. There were no signs of fire or soot on the fin.

Figure 7. Empennage

The horizontal stabilizer's center section, trim actuator and ballscrew showed no external damage.

At the time of the accident the wing flight control surfaces were consistent with the landing configuration. It was confirmed by the position of the leading and trailing edge flaps - all the way to the wing final stop.

Spoilers actuators with fragments of control surfaces were found, their position showing that at the time of the accident the spoilers were retracted (actuator drive cylinders pilled in).

The external examination of the cockpit revealed both pilots' control columns bearing no external damage.

The elevators remained installed on the aircraft consistent with a pitch-up position. The mechanical coupling between the elevators and servo tabs was intact.

The LH aileron was torn. The RH aileron was broken into pieces. It was not possible to determine the aileron position at the time of the impact.

The pilots' pedals had no external damage. The rudder consisting of two halves was not broken. It was not possible to determine the rudder position at the time of the impact.

There are no signs of liquid spillage or kinematics disconnect. The deformation and damage to the control cables, ducts and cords is consistent to the deformation and damage to the tail fuselage.

1.13. Medical and Pathological Information

The investigation team is awaiting the results of the forensic examination of the persons killed in the accident.

1.14. Survival Aspects

The 4 crew members and 35 local residents of Dacha-SU settlement were killed by the crashed a/c and post-crash fire. 37 local residents got injuries of varying severity.

It has been revealed that both the PIC and the FO were in their respective seats and fastened.

1.15. Search and Rescue Operations

Being analyzed.

1.16. Tests and Research

On 16.01.2017 the quality control laboratory of fuels and lubricants (Manas Airport) examined fuel samples drained from the LH wing (Sampling Act № 1-2 as of 16.01.2016). Based on its results it was conclude that the fuel met the pertinent specifications.

FCC PN 822 1261-101 SN 144295 recovered from the accident site has been sent to the NTSB in Washington DC, USA for specific examinations.

An inspection flight of Manas ILS has been performed as per a specifically designed program coordinated with all participating States.

1.17. Organizational and Management Information

Being analyzed.

1.18. Additional Information

1.18.1. FMA FAULT 2

As per the Boeing Company explanation, FMA FAULT 2 record means that the AFDS identified pitch mode failure that is the a/c could no longer be tracking the glideslope beam (see FCT 747 Pages 5.19 - 5.20).The mode failure results in the following:

- the pitch flight director bars are removed from the PFDs;
- a yellow line is displayed through the G/S mode annunciation on the PFDs (FMA);
- both MASTER CAUTION lights are illuminated;
- a MASTER CAUTION aural is activated;
- an amber AUTOPILOT caution message is annunciated on EICAS.

Meanwhile the A/P will not disengage. In the pitch channel the A/P will maintain an inertial path which tracks a constant 3□ slope regardless of the actual glideslope angle at a certain

airdrome. The path will be maintained until a valid glideslope signal is regained or until the crew intervenes by disengaging the A/P or initiating a go-around (TOGA switch pushed).Without crew intervention the A/P will maintain the inertial path until the FLARE mode is engaged. The Autoland status LAND 3 (or LAND 2) will also continue being annunciated. According to the manufacturer's information the inertial path generation is a feature in Boeing airplane models 737, 747-400/-8, 757, 767, 777, 787 that allows the A/P to continue the approach for disruptions of either G/S or LOC ground station signals.

1.18.2. "GLIDESLOPE" alert (EGPWS Mode 5)

According to the EGPWS Manufacturer's Pilot Guide, below 1000 ft radio altitude, a deviation of 1.3 dots below the glideslope will trigger a 'soft' alert with a caution light and an aural GLIDESLOPE alert at 20% of full volume. Once below 300 ft radio altitude, a deviation of 2.0 dots below the glideslope beam will trigger a 'hard' alert with the aural alert sounding repeatedly at full volume.

2. Safety Recommendations

1. It is recommended that the crews pay attention to following approach charts, monitoring distance and altitude during reference points (FAF, LOM, LMM) overflight when conducting ILS approaches, especially ICAO CAT II and CAT III approaches.

2. It is recommended that flight crews be informed that in case ground references are not visible, go-around shall be initiated not lower than the established decision height.

3. It is recommended that air traffic controllers, in case they have pertinent equipment available, inform flight crews on significant altitude deviations from that established by the approach charts, especially for ICAO CAT II and CAT III approaches and Low Visibility Procedures, therefore, introducing respective amendments to the procedures and job description of air traffic control personnel should be considered.

4. It is recommended that top management of airlines operating Boeing aircraft (all models) arrange theoretical and practical (if needed) training to cover awareness, procedures and aspects of flight operations when A/P switches to inertial mode during glideslope descent. Consider the applicability of this recommendation to aircraft of other manufacturers.

5. It is recommended that the FAA in cooperation with the Boeing Company consider the practicability of changing the A/P logic to prevent occurrences of following inertial glideslope descent (in LAND 3 or LAND 2 mode) in cases when approach path does not allow landing in the appropriate area on the runway. It is recommended that other certification authorities and aircraft manufacturers consider the applicability of this recommendation taking into account actual A/P algorithms.

6. It is recommended that airport administrations analyze the acceptability of constructions in immediate vicinity of airdromes and, in case findings are raised, take appropriate decisions in cooperation with pertinent authorities.